

Biology of the North American Crane Flies (Tipulidæ, Diptera)

II. *LIAGMA NODICORNIS* Osten Sacken

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The genus *Liogma* belongs to the tribe *Cylindrotomini*, an interesting group of the Tipulidæ. Baron Osten Sacken in the Monographs of the North American Diptera speaks of them as a "small, but very remarkable group of species, occupying an isolated and intermediate position between the *Tipulidæ brevipalpi* and *longipalpi*." The structure of the adult flies, especially as regards certain details of the venation of the wings, is quite unique but it is in the immature stages of the different genera that the most interesting distinctions are found. The larva, instead of living in the mud along the banks of streams or in rotten wood as do the majority of the known crane-fly larvæ, dwell upon the leaves of various terrestrial and aquatic plants; instead of being brown or grey in color, they are bright green and usually resemble the leaves of their host-plants to a very remarkable degree.

The larva of *Cylindrotoma distinctissima* Meigen lives on the lower surface of the leaves of various plants (*Stellaria* L., *Anemone* (Tourn.) L., *Viola* (Tourn.) L.) and eats elongated holes in them. The larva before undergoing its transformations, leaves its host-plant and crawls to some grass-stalk, where it passes the pupal stage. The larva of *Triogma trisulcata* Schummel, is aquatic, living on the leaves of the submerged moss, *Fontinalis antipyretica* L., in small alpine streams where it was first found in Saekingen at an altitude of nearly 4000 feet; it spends the winter as a larva, the first specimens being found by Prof. Steinmann at the end of April, fourteen days

* Contribution from the Limnological Laboratory of the Department of Entomology in Cornell University.

after the melting of the snow. The larva of *Phalacrocera replicata* L. has long been known to entomologists as it was first figured by Degeer in 1776. It lives in the water amongst the aquatic plants and mosses; Bengtsson and Mueggenburg believe that it has but one generation in a year, spending the entire winter in the larval state; Miall and Shelford, however, think that it is possible that there are two or more generations of *Phalacrocera* in a single season. The species of the genus *Liogma* O. S. are terrestrial, and live on mosses of the genus *Hypnum* Dill. They will be considered in detail in the remainder of the paper.

The genus *Liogma* was proposed in 1869 by Osten Sacken for the two species known at the time, *Cylindrotoma glabrata* Meigen of the western Palearctic region and *C. nodicornis* Osten Sacken of the eastern Nearctic region. The erection of the genus at this time was merely tentative and neither species was designated as type; it was not until later that the American *nodicornis* was chosen. A third species, *Liogma kuwanai* Alexander, has been described from the eastern Palearctic region but of this form only the adult fly is known.

The larva of the European species, *Liogma glabrata*, was first found by Mr. DeRossi in 1876, but its discoverer was quite at a loss to identify his remarkable insect. In 1878, Osten Sacken, using this short description of DeRossi, pointed out the affinities of this larva with the *Cylindrotomini* and suggested that it was the larva of *Triogma*, then unknown. In 1901, Dr. Mueggenburg's excellent paper on *Liogma glabrata* appeared and the larva and pupa are therein described in great detail. The larva of *glabrata* was found in the woods in the environs of Berlin, in grassy wet spots where the moss, *Hypnum squarrosus* Brch. & Schp., occurs. The following interesting details are taken from Dr. Mueggenburg's paper: the complete metamorphosis of the insect requires one year, of which time but a comparatively short period is occupied by the egg (8 to 10 days) and pupal state (11 to 12 days). The duration of the adult life is not known but it is certainly short and even in the male sex occupies but a few weeks at the

maximum. Near Berlin, the flies emerge during the first half of July. The males appear first, the females later, and these latter were always seized in copulation by the males just after they had forsaken the pupal skin and while still teneral and undeveloped. (In this regard compare also Mik (Entomol. Nachricht, p. 200, pp. 315, 316, 1886); and Candell (Proc. Ent. Soc. Wash., pp. 45-46, 1913). Each female lays about sixty eggs (like *Phalacrocera*, according to Miall and Shelford) and these are deposited singly on the leaves or branches or attached lightly to the axils of the leaves of *H. squarrosum*. The female dies soon after the accomplishment of oviposition. The larvæ when newly emerged, lack the beautiful moss-green color of the later stages and are ashy-grey. The animal grows very slowly in the autumn, and throughout the winter is still very small and difficult to detect. In the spring the growth is greatly accelerated and the larva becomes fully grown during the latter half of June. While growing, the animal molts several times, probably at least eight, the number determined for *Phalacro-cera* by Bengtsson. Pupation occurs in the moss where the larva happens to be. In its green color with brown blotches, the larva simulates remarkably the color of the host-plant and the effect of the shadows cast by various foreign bodies such as plant-stems and leaves. As Mueggenburg says: "so completely does our larva harmonize with its environment that even a practiced eye succeeds only after long inspection in discovering it on the moss branches." The extreme sluggishness of the larva, so characteristic of the American *nodicornis*, is described for this form. Considering our very scanty knowledge of the immature stages of crane-flies, Dr. Mueggenburg's statement that the distribution of the larva is restricted by the distribution of this one moss, *Hypnum squarrosum*, must be taken to be a little too extreme. I have but little doubt but that the larva of *glabrata* will be found on other related species of *Hypnum* when further collections are made.

The American species, *nodicornis*, is of especial interest since it is the genotype. The larva was first observed around Ithaca, N. Y., in the spring of 1913. On May 7, Miss Eudora

F. Tuttle found a large, nearly full-grown larva in moss, *Hypnum cupressiforme* L.* in Cascadilla gorge; the specimen was given to me on the 11th and placed in breeding-jars containing damp moss of the same species. On May 8th, I went to Coy Glen, near Ithaca, and there sifted a dead larva from another species of *Hypnum*; on May 11th I secured another larva from the moss in Cascadilla gorge, and this specimen was likewise transferred to my breeding-jars. On May 25th when these jars were examined, it was found that both specimens had pupated but were still very pale and uncolored. On May 30th, one female emerged from these pupæ and was identified as being this species.

The larvæ of *Liogma* are the most sluggish of any crane-flies known to me. They move only with great slowness and at most times appear to be quite dead. They crawl about amongst the stems of their host-plant and probably never leave it, not even to pupate.

At Orono, Maine, I sifted some *Hypnum* in Standpipe woods on June 16th and found two fully-colored pupæ, which were killed for specimens on June 17th; on the latter date I found a third pupa in the same woods.

In nature the insects probably emerge about the middle or latter part of June and adult flies may be found in June and July. The rapid development and early emergence of these flies in breeding-jars where they are influenced by artificial conditions of heat, light and moisture has been mentioned earlier by Dr. Mueggenburg and others. In our breeding-jars the length of the pupal stage was apparently not more than six days but in the field it is undoubtedly longer.

In the northern part of its range the adult flies probably do not appear before July (Kearner, Ont., July 9, '09; St. Johns, Queb., July 20, '01). In the northern United States the insects are on the wing in late June and early July. (Orono, Me., June 8, '13; Ellsworth, Me., June 15 to July 4, '13; Machias, Me., July 25, '07; Manchester, Vt., June 6, '10; Montpelier, Vt., June 25, '06). In New York state the flies are common in damp

* Determined by Mr. H. D. House and Prof. C. H. Peck of Albany, N. Y.

swampy woods supporting a Canadian fauna and flora. In Fulton county, N. Y., I have taken the form in the gorge of the Cayudntta creek at Johnstown on June 15, '09, which is the earliest date for the county. At Mountain Lake bog-pond both sexes were found in abundance on June 26, '09. At Vandenburg's pond on June 19, 1911, I found the insect in numbers and a living female placed in a vial with a male *Phalacrocera tipulina* was taken in copulation at once and remained "in coitu" for several hours. The last specimens for the year in this county were found at Sacandaga Park on June 27, 1911. As we approach the southern limit of their range they probably emerge in late April or early May. (Hazleton, Pa., June 8, '10; Wooster, Ohio, May 31, '12; Black Mountains, Buncombe county, N. C., May 23, '12). The adult insects are sluggish and do not fly readily and they may be swept from the vegetation that surrounds their haunts. They frequent the rank growth around small shaded ponds where they occur with numerous other crane-flies of the Canadian fauna. At Ithaca, this form is most common in the gorges and on the moist shaded hillsides to which little sunlight penetrates.

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A KEY TO THE KNOWN LARVÆ OF THE CYLINDROTOMINI

1. Body appendages long, filiform; aquatic or nearly so on
Fontinalis antipyretica, *Hypnum elodes*, *H. exannulatum*,
Ranunculus fluitans, etc.
(Palearctic) *Phalacrocera replicata* L.
2. Body appendages shorter, leaf-like. 2
2. Dorsal appendages all simple; terrestrial on *Viola biflora*
V., *Stellaria nemoralis*, *Anemone nemorosa*, etc.
(Palearctic) *Cylindrotoma distinctissima* Meig.
- Some of the dorsal appendages bearing teeth on the anterior
convex side. 3

3. Some of the dorsal appendages bearing four teeth on the anterior face; aquatic on *Fontinalis antipyretica*.
(Palearctic) *Triogma trisulcata* Schumm.
The dorsal abdominal appendages with not more than two teeth; terrestrial on *Hypnum*. 4
4. Most of the dorsal appendages bearing two teeth; on *Hypnum squarrosum*.
(Palearctic) *Liogma glabrata* Meig.
Most of the dorsal appendages bearing a single lateral tooth; on *Hypnum cupressiforme* and a related species.
(Nearctic) *Liogma nodicornis* O. S.

Larvæ of the *Cylindrotomini* may be distinguished from those of other crane-flies by the following easily determined points: color green or greenish; the body provided with filiform or leaf-like appendages; larvæ living upon various Bryophytic or Spermatophytic plants.

A KEY TO THE KNOWN LARVÆ AND PUPÆ OF THE GENUS *LIOGMA*
OSTEN SACKEN

LARVÆ

1. Prothoracic segment bearing four conspicuous dorsal projections about in a line. Meso- and metathoraces with two pairs of dorsal appendages, each bearing two lateral teeth in front. Second abdominal segment with four dorsal appendages of which the last two bear two teeth in front.

glabrata Meigen

Prothoracic segment bearing four inconspicuous dorsal tubercles. Meso- and metathoraces with two pairs of dorsal appendages, the anterior pair small, both pairs simple. Second abdominal segment with four dorsal appendages of which the last two bear a single small tooth in front.

nodicornis Osten Sacken

PUPÆ

1. Pronotal breathing horns directed cephalad and dorsad. Mesonotum bearing two pairs of spines, the more anterior being the smaller, situated just behind the breathing-horns, the posterior pair larger. Metanotum with two pairs of spines. Abdomen with the first tergite bearing two pairs of spines of which the first has two lateral branches, the second simple; the second tergite bears two

pairs of spines of which the first has two lateral branches, the second, one branch; the third tergite bears three pairs of spines of which the first is very short and simple, the second with two lateral branches, the third with one branch; tergites IV and V with three pairs of branches of which the first two are similar to those of the third segment, the last possessing two lateral branches.

glabrata Meigen

Pronotal breathing horns directed cephalad and ventrad. Mesonotum spineless. Metanotum with one pair of spines. Abdominal tergites bearing but a single pair of appendages which are unbranched and correspond in position to the last or more posterior of those of the European species.

nodicornis Osten Sacken

DETAILED CHARACTERIZATION OF THE IMMATURE STAGES OF LIQGMA NODICORNIS O. S.

LARVA (Plate I)

Fully grown, length, 14.5-15 mm.; maximum breadth, 3 mm.; maximum depth, 2.5 mm.

Color when living, light green, the numerous spines which cover the body are darker; sides with seven oblique marks, the first of which is on the first abdominal segment, the last on the seventh; the marks on the ends are the smallest and least distinct, the five intermediate marks being large and conspicuous; these marks of one side are all parallel to one another; the caudal face of the ventral lobes which protect the stigmal field, deep black.

Head retracted into the first thoracic segment. Antennæ two-segmented, the basal segment elongate-cylindrical, the tip very short, thimble-shaped, its diameter less than that of the elongate basal segment. Maxillæ with the palpi very short and broad, the basal segment chitinized, the tip narrow, pale; the shape of the maxilla and its palpus is shown in figure 3 of plate I. The mandible works vertically; many-toothed on the inner face at the tip as shown in figure 2 of plate I. The labium has about seven teeth on either side, the ones on either side of the median line being the larger (figure 4 of plate I).

Prothorax, in front, sloping from the anterior end, on the ventral slope provided with the lip-like lobes and the transverse slit through which the head-capsule is exerted. The upper lip is the higher, not strongly chitinized, provided with a few small scattered bristles which are more numerous on the sides of the lobe; lower lip not so high, with small scattered bristles that are not arranged in a row as in *glabrata*. At the angle of the slit is a small rounded lobe bearing a small bristle. Dorsal body appendages reduced to a pair of lobes in front separated by a space a little wider than one of them, and a pair of smaller ones behind very widely separated. Lateral body appendage long, conspicuous. Ventral body appendages not apparent.

Meso- and metathoraces swollen and arched ventrally like the prothorax. Dorsal appendages two, a small conical one in front and a much larger one behind which bears a small tooth in front and with its tip directed backward. Lateral appendages viewed from above, two in number, the anterior one larger, directed sharply backward, the second smaller, conical. Ventral appendages viewed from the side, two, of which the anterior one is the larger, the posterior pair small, slightly behind the others.

Abdominal segments, dorsal appendages: first segment with two pairs of appendages, the anterior shorter, conical, the tip strongly recurved and bearing a tiny tooth on its anterior face at about midlength; the posterior are much longer with the tip bent strongly backward, a small tooth on the anterior face at about one-third the length. Segments II to VII with four pairs of appendages, the first very small, conical; the second exactly similar but larger; the third and fourth similar to those appendages of the first abdominal segment; the tiny first appendage is largest on the second segment, becoming smaller toward the end of the body. Lateral appendages: first segment with three appendages, the first of which is directed laterad, the posterior two more recurved and directed caudad. Segments II to VII with four pairs of lateral appendages of which the first is very small, situated at the antero-lateral angle of the segment, the other three teeth are subequal and directed caudad. Ventral appendages, first segment with three pairs of appendages which

are successively larger, from the short anterior one to the large posterior one. Segments II to VII with five pairs of appendages of which the first three are small, the fourth intermediate between them and the enlarged fifth.

Eighth segment bearing the stigmal field and the caudal appendages. Dorsal side of this field with a pair of long slender lobes which are bent conspicuously cephalad. Stigmal field (figure 5 of plate I) very small, oval, the two rounded-oval stigmata are situated side by side and close to one another, facing one another and capable of being closely appressed. On the ventral side of the stigmal field are two lobes, directed ventrad, which Dr. Mueggenburg regards⁶ as being the ninth segment, the inner faces of these lobes with a conspicuous jet-black line, the tip ending in a sharp recurved hook. Ventral surface of the terminal segments with small protuberances.

PUPA (Plate II)

Length from head to the tip of the abdomen, ♂, 10.4-11.4 mm.; ♀, 10-13 mm.

Length from head to tip of tarsi, ♂, 5.2-5.3 mm.; ♀, 5.1-5.4 mm.

Dextro-sinistral width at the wing-pad, ♂, 2-2.2 mm.; ♀, 2.2-2.6 mm.

Dorso-ventral depth at the wing-pad, ♂, 1.9-2.2 mm.; ♀, 2.1-2.5 mm.

Living pupæ have the breathing horns light yellow, the terminal half a little more brownish; a brownish-black mark on the prescutum; the abdomen is greenish, more yellow behind; the dorsal spines are clear light green throughout, occasionally the tips a little infuscated. Alcoholic pupæ—mesonotal prescutum with a dark brownish-black mark, irregularly U-shaped, the arms of the U directed backward, the dark color produced caudad and cephalad along the middle line from this mark; a triangular or rounded black spot on either side of the scutellar lobe; metanotum with a large blackish median blotch which is continued cephalad onto the mesonotal postnotum. Abdomen with an interrupted brownish-black longitudinal line along either side of the middle of the dorsum; the caudal margin

of each tergite suffused with brown. In old and fully colored pupæ, the bases of the dorsal spines are brown, the tips paler; the head and thorax with appendages brown, sometimes very dark; abdomen yellowish.

Male—Bases of the antennæ approximated on either side of the middle line of the venter lying between the cephalic half of the compound eyes; antennæ rather enlarged, directed cephalad, bending around the anterior margin of the eye and thence directed caudad; the antenna ends between the fore tibiæ and femora just beyond the joint, the tip about on a level with the lobes of the labium; in older pupæ the peculiar nodose segments of the imago show through the sheath. Eyes rather large; labrum elongate, slender. Cephalic portion of the head very flat and broad without spines; a small blunt tubercle between the antennal bases.

Pronotal breathing horns large, conspicuous, directed dorsad and laterad, the apical half bent rather suddenly cephalad. Mesonotum feebly wrinkled. Metanotum with two long slender spines arising beyond midlength of the segment, directed caudad and scarcely dorsad, their tips parallel or slightly convergent. The fore femur is long, ending on a level with the caudal portion of the eye; the fore tarsi are shortest, the hind tarsi longest, this relation holding for all the tarsal segments throughout; the tip of the hind legs is just before the caudal margin of the third abdominal segment. Wings broad, reaching the caudal margin of the second abdominal segment.

Abdomen, viewed from above, with the first segment about one-half as long as the second; segments II to VII subequal in length. Tergites I to VII bear a long slender spinous projection from either side of the median line, shortest on the anterior segments, longest on the seventh segment. These projections arise from near the caudal margin, those on the anterior segments more parallel, those on the rear segments becoming divergent; these projections are directed caudad and dorsad, those behind being almost perpendicular to the body. Segments II to VII have the lateral margins produced into three sharp spines, these spines being near the base, middle and caudal portion of

each segment. These spines are directed laterad and caudad, the terminal spine more sharply caudad than the other two. Sternites—Segment III with a small subapical spine on either side, these being very widely separated, about midway between the median line and the lateral margin of the segment; segment IV with the same spines but larger and more prominent; segments V to VII similar but with another pair of small spines about midlength of the segment and much nearer to the middle line of the body. Segments II to VII with a subbasal triangular pit or mark, widely separated. Eighth tergite with the caudal margin rounded, concave, the lateral angles produced backward, upward and slightly outward as strong spines; suture on the ventral surface incomplete; two small spines on either side of the middle line of the body. Ninth tergite produced caudad as two strong, parallel, spinous projections. Hypopygium from beneath, the lower valve very long, about concealing the dorsal valve, at its tip with four small spines directed outward and caudad, these spines on the caudo-lateral angle of the segment. (See figure 1 of plate II).

Female—Very similar to the male, the antennal sheaths smaller and not so closely approximated basally; the lower valve of the ninth segment slender, obtuse at apex, feebly notched; upper valves broader, longer, with a deep median split, the lobes rounded. (See figures 3 and 4 of plate II).

Larva described from one specimen taken in Coy Glen, Ithaca, N. Y., May 8, 1913.

Pupæ described from two females; Cascadilla creek, Ithaca, N. Y., killed on May 30, 1913. (One taken as a fully-grown larva, May 7, 1913, by Miss Eudora F. Tuttle; the other taken by the author as a larva on May 11).

Two pupæ from Orono, Maine, killed on June 17, 1913, and a third fully-colored specimen from the same place on June 19.

A BIBLIOGRAPHY OF THE IMMATURE STAGES OF THE CYLINDROTOMINI

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EXPLANATION OF THE PLATES

PLATE I. THE LARVA.

- Figure 1. Dorsal aspect of the larva.
Figure 2. Mandible, lateral aspect.
Figure 3. Mandible, ventral aspect. *a*, mandible; *b*, antenna.
Figure 4. Mouthparts, ventral aspect. *a*, maxillary palpus; *b*, stipes; *c*, cardo;
d, labium.
Figure 5. Caudal end of the larva, caudal aspect, looking into the stigmal field.
Figure 6. Lateral aspect of the larva.

PLATE II. THE PUPA.

- Figure 1. Lateral aspect of the pupa; male.
Figure 2. Dorsal aspect of the pupa; male.
Figure 3. Dorsal aspect of the end of the abdomen; female.
Figure 4. Ventral aspect of the end of the abdomen; female.